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REMARKS

Claims 1,3, and 5-9 remain in the case. Claims 1 has been amended.

Applicant expresses gratitude for the interview conducted on May 25, 2007.

Claim 1 and claim 6 recite a method and apparatus, respectively, for operating an automotive engine including fuel injectors that open to deliver fuel to the engine. A mechanical returnless fuel system is provided for supplying fuel to the fuel injectors and also includes a fuel pump having a pump output. The pump output is substantially constant. The controller regulates an opening time for the fuel injectors to deliver the precise quantity of fuel. A diaphragm-less pressure regulating valve is provided within a fuel tank and returns a portion of the pump output to the fuel supply instead of to the fuel injectors. The pressure regulating valve produces a fuel pressure that varies as a function of the engine fuel demand.

Minagawa is an electronic returnless fuel pump system which includes a pulse-width modulated fuel pump. Minagawa changes the current provided to the fuel pump to increase/decrease the fuel pump output for controlling the fuel pressure provided to the fuel injectors without any need for a regulating valve. Fuel pressure is estimated based on the fuel flow supply rate which is controlled by the electric varying supply current, and as a result, Minagawa delivers the exact amount of fuel required by the injectors. Minagawa is an entirely different basic structure than the present invention. To modify Minagawa to suggest a mechanical returnless fuel system that provides the substantially constant pump output as recited in the present invention is neither practical nor obvious to do.

Powell describes a returnless fuel system that uses two conventional diaphragm-type pressure regulators. Diaphragm-type pressure regulators, as known in the art, maintain a constant fuel pressure. When a diaphragm-type regulator is used, a constant pressure is maintained in the fuel lines as illustrated by the ideal constant pressure curve 72 shown in Fig. 2 of the

present invention. In Powell, the first pressure regulator (23) is disposed within the fuel tank (13) and maintains a constant pressure within the fuel line (16). The second pressure regulator (10) maintains a constant pressure in the fuel rail (20) by exposing the chamber of the pressure regulator to atmospheric pressure. If the pressure regulator is to change with mainifold vacuum, then the pressure regulator is exposed to the manifold vacuum resulting in a constant pressure across the injectors. As a result of utilizing the two diaphragm pressure regulators, the fuel system is not only complex but expensive.

The fuel system of the present invention utilizes a single pressure regulator. The pressure regulator is an unconventional regulator that does not utilize a diaphragm-type pressure regulator. The diaphragm-less pressure regulator outputs a non-constant pressure output as illustrated by the pressure curve 70 shown in Fig 2. Each of the pressure regulators described in Powell including the pressure regulator referenced in the three patents (US 5193576, US5163472, US 5193576) are examples of the conventional diaphragm pressure regulators. As stated earlier, the pressure regulator (23) of Powell provides a constant pressure whereas the pressure regulator of the present invention outputs a non-constant pressure. Therefore, in the present invention, pressure provided to the fuel rail varies in proportion to the engine fuel flow rate. A controller determines a precise quantity of fuel required for optimum engine operation based upon engine operating parameters (i.e., projected engine fuel demand). The projected fuel engine fuel demand is used as the fuel flow rate to determine an estimated fuel pressure which is derived on pressure/fuel flow rate curve 70 (e.g., look-up table) shown in Fig. 2. The controller then calculates the opening times for the fuel injectors given the estimated fuel pressure within the fuel rail. As a result, a non-constant pressure is provided to the fuel rail and the opening times of the fuel injectors are determined based on the non-constant pressure within the fuel rail. In contrast, an estimated fuel pressure based on fuel flow rate is not required in Powell since the diaphragm regulators provide a constant pressure regardless

of the fuel flow rate. Therefore, claims 1 and 6 recite a system that eliminates the need for complex and expensive fuel system components by utilizing an unconventional pressure regulator in a manner that has been neither shown or used in the art. The mere fact that this invention has simplified and eliminated the more complex and costly components does not take away from the novelty of the invention or make it obvious if it is done so in a novel and nonobvious way. The fact that the applicant has invented a fuel system with reduced complexity while others have failed to do so when such changes to fuel systems would be advantageous in regards to complexity and cost is a clear indication that the present invention was not obvious to one skilled in the art. Minagawa and Powell, in combination, fail to teach or suggest each of the limitations of the present invention. The Office action has individually referenced complex components and systems while suggesting that it would be obvious to substitute the unconventional components as recited in applicant's instant application. The examiner is utilizing hindsight because applicant has simplified the fuel system but has done so in a manner that in non-obvious to one skilled in the art. Minagawa and Powell fail to describe or suggest, either in combination or individually, the limitations of claims 1 and 6. Therefore, claims 1 and 6 are allowable.

Claims 3 and 8 recite the step of determining an estimated fuel pressure based off of the fuel pressure-fuel flow rate relationship includes the step of using a look-up table. The present invention utilizes a look-up table to estimate the fuel pressure-fuel flow rate relationship of the fuel in the fuel rails. In contrast, Gaskins describes utilizing a look-up table to control the pressure output of the fuel pump. As a result, Gaskins changes the pump's output whereas the present invention maintains a constant pressure output. It has been discussed earlier that the although the pump output is constant, the fuel pressure in the fuel lines and fuel rail are non-constant. The look-up table is used to determine the fuel pressure-fuel flow relationship for controlling the opening times of the fuel injectors. Gaskins fails to describe or suggest a look-up table to determine an estimated fuel pressure in the fuel rail that is

used to determine the opening time of the fuel injectors. Therefore, claims 3 and 8 are allowable.

Claim 5 depends from claim 1 and is therefore allowable.

Claim 7 recites the pressure regulating valve produces a fuel pressure in the fuel line that varies based upon actual engine fuel demand. The pressure regulator, of the present invention, is disposed within the fuel tank. The pressure regulator disposed within the fuel tank varies the fuel pressure to the fuel rail based on the actual engine fuel demand as a result of engine vacuum coupled to the fuel rail. In Powell, the pressure regulator disposed within the fuel tank does not vary fuel to the fuel rail based on the engine actual fuel demand. Rather, the diaphragm pressure regulator outputs a constant fuel pressure to the fuel line. A second pressure regulator coupled between the fuel tank and fuel rail outside of the fuel tank is also coupled to a switch mechanism to drive the pressure regulator either at atmospheric pressure or engine vacuum. Powell describes a complex system utilizing costly components to deliver fuel to the engine. Powell fails to describe a pressure regulator disposed within the fuel tank that varies the fuel pressure of the fuel to the fuel line base upon engine demand. Therefore, claim 7 is allowable.

In view of the foregoing amendment and remarks, all pending claims are in condition for allowance. Favorable action is respectfully solicited.

Respectfully submitted,

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